US008851158B2

(12) **United States Patent**
Alahyari et al.

(10) **Patent No.: US 8,851,158 B2**

(45) **Date of Patent: Oct. 7, 2014**

(54) **MULTI-CHAMBER HEAT EXCHANGER HEADER AND METHOD OF MAKING**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 1508 days.

(21) Appl. No.: **12/378,500**

(22) Filed: **Feb. 17, 2009**

(65) **Prior Publication Data**

US 2010/0206532 A1 Aug. 19, 2010

(51) **Int. Cl.**
F28F 9/22 (2006.01)
F28F 9/02 (2006.01)

(52) **U.S. Cl.**
CPC ***F28F 9/0217*** (2013.01); *F28F 2275/04* (2013.01); ***F28F 9/028*** (2013.01); *F28F 2275/06* (2013.01); *F28F 2255/16* (2013.01); *F28F 2275/14* (2013.01)
USPC **165/174**; 165/175

(58) **Field of Classification Search**
USPC 165/144, 174, 176
See application file for complete search history.

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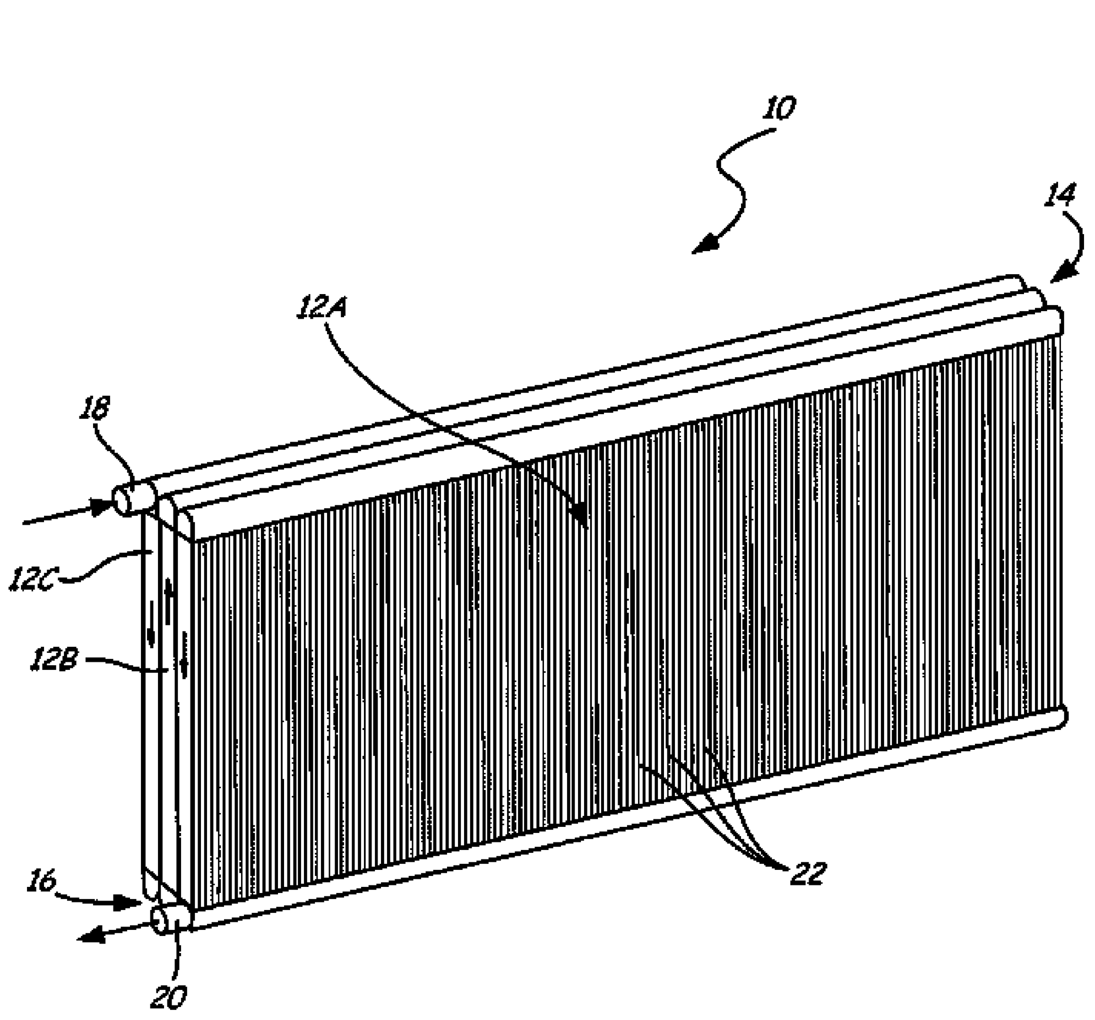
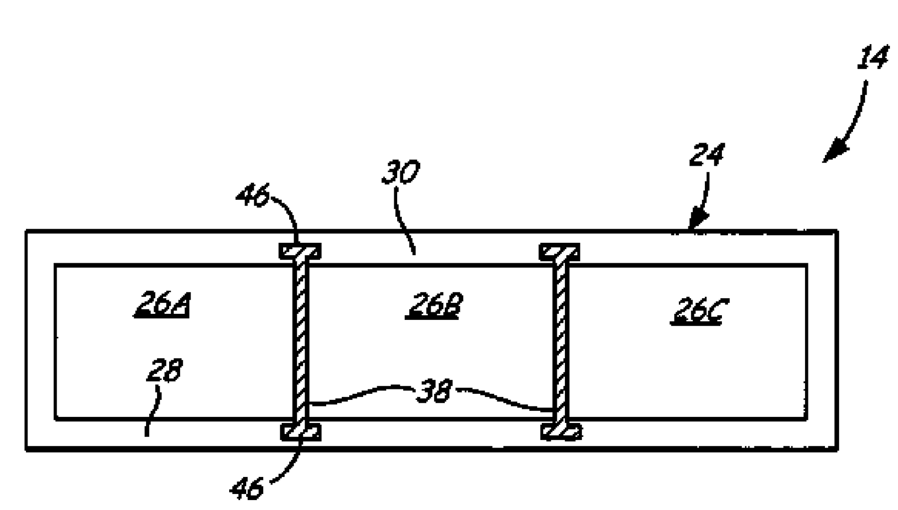
(57) **ABSTRACT**

A multi-chamber heat exchanger header includes a header housing and an insert. The header housing has a first wall and a second wall generally opposite the first wall where the first and second walls define a track. The insert is positioned to engage with the track such that the insert separates the header into first and second manifold chambers. A method for forming a multi-chamber heat exchanger header includes extruding a header housing having first and second manifold chambers and a track, positioning an insert in the header housing to engage with the track, and welding or brazing the insert to the header housing.

12 Claims, 5 Drawing Sheets





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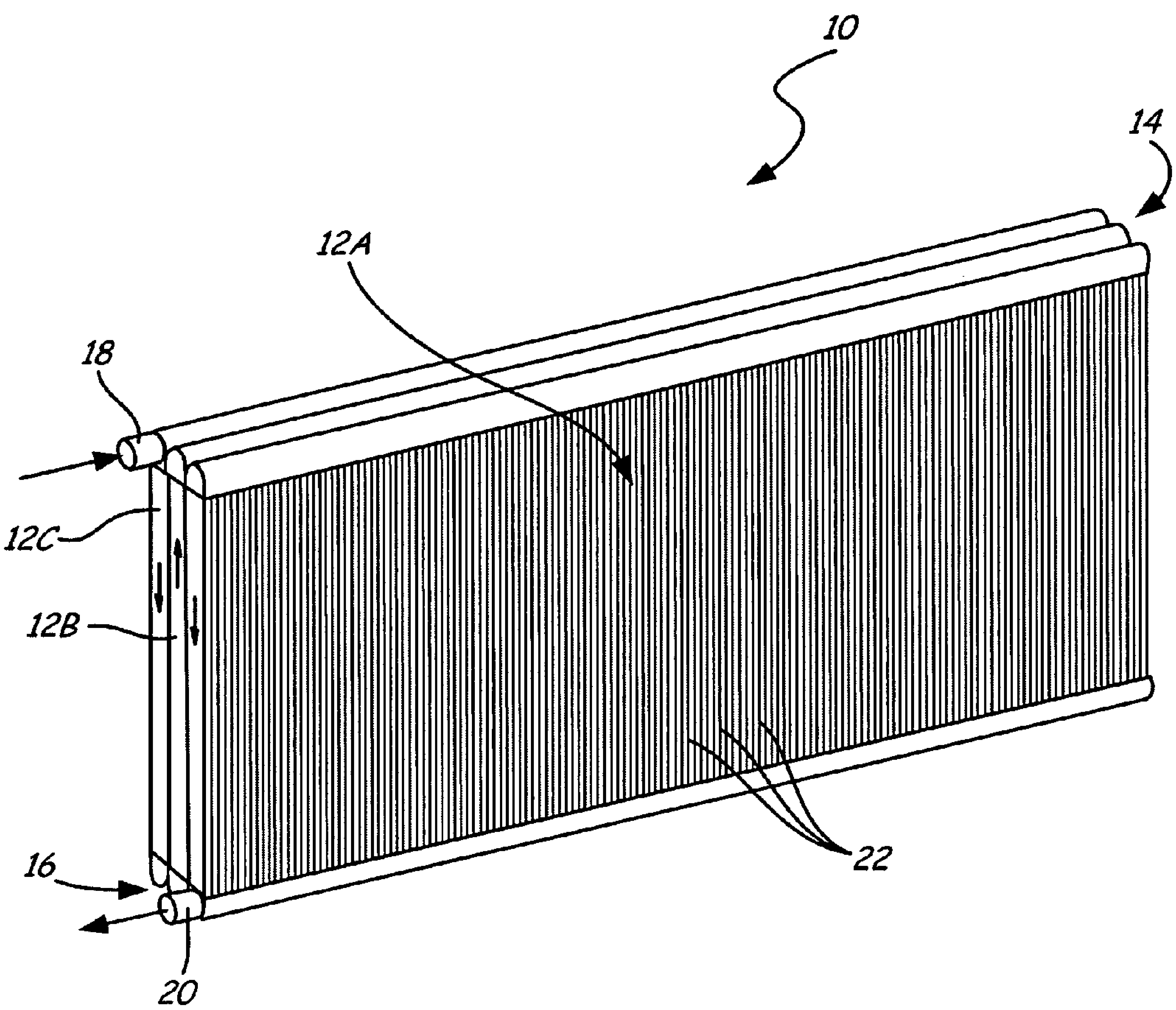

FIG. 1

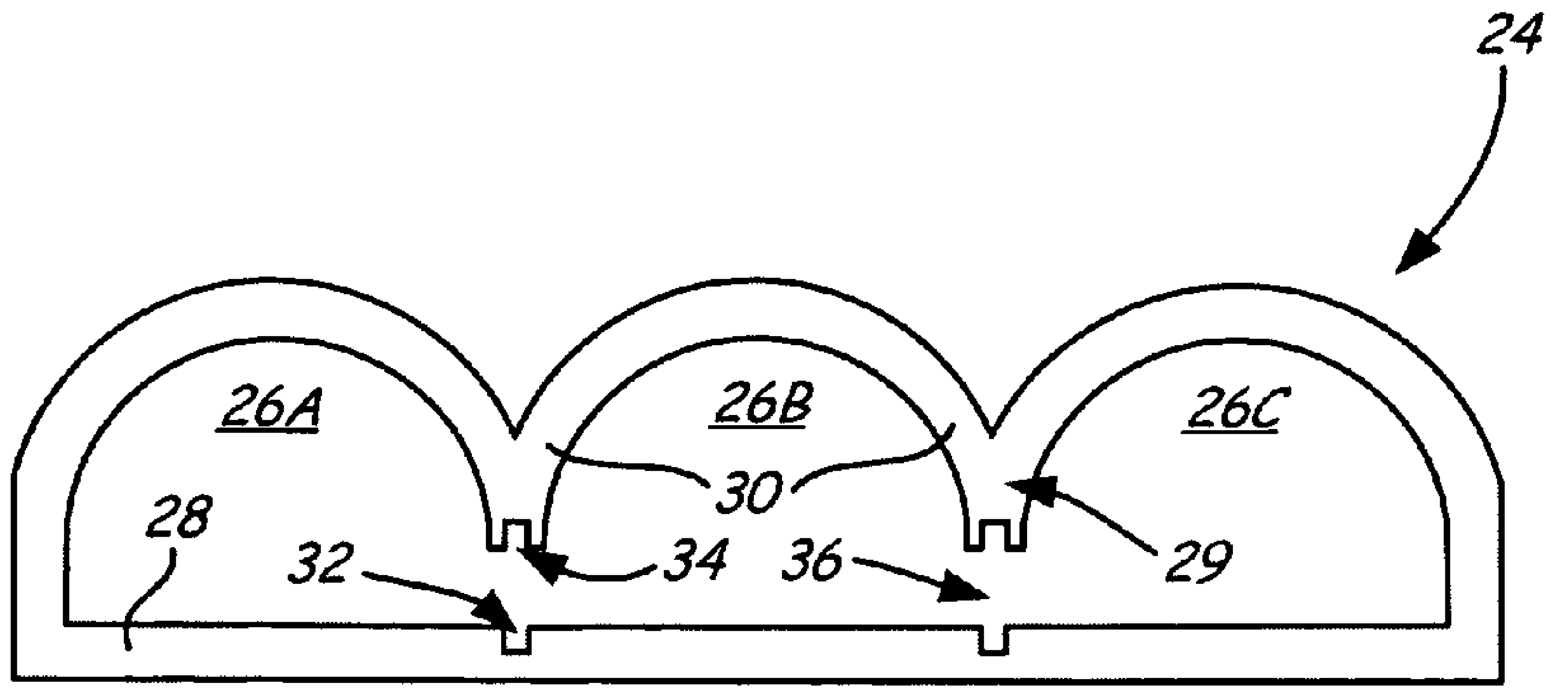

FIG. 2

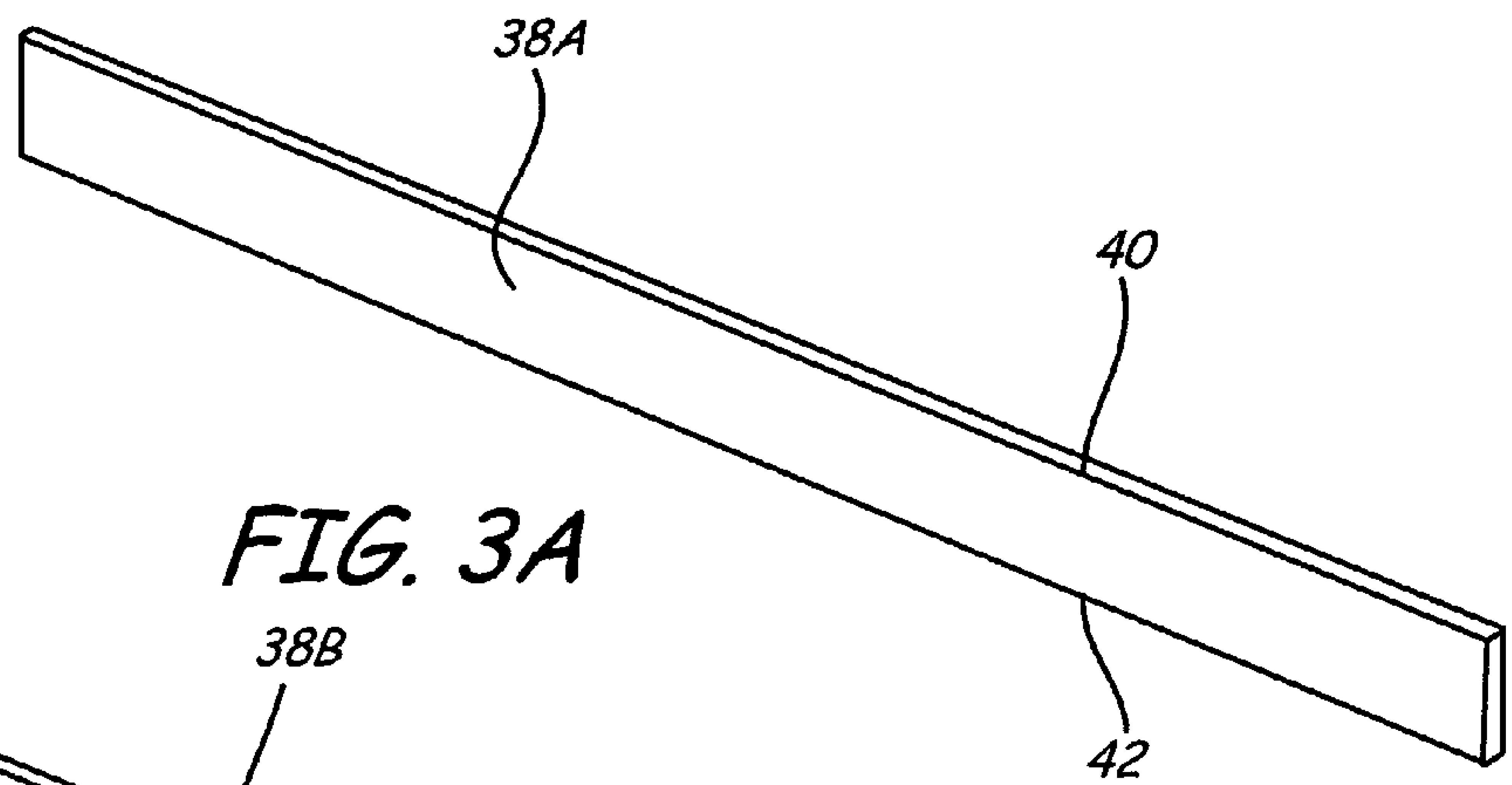

FIG. 3A

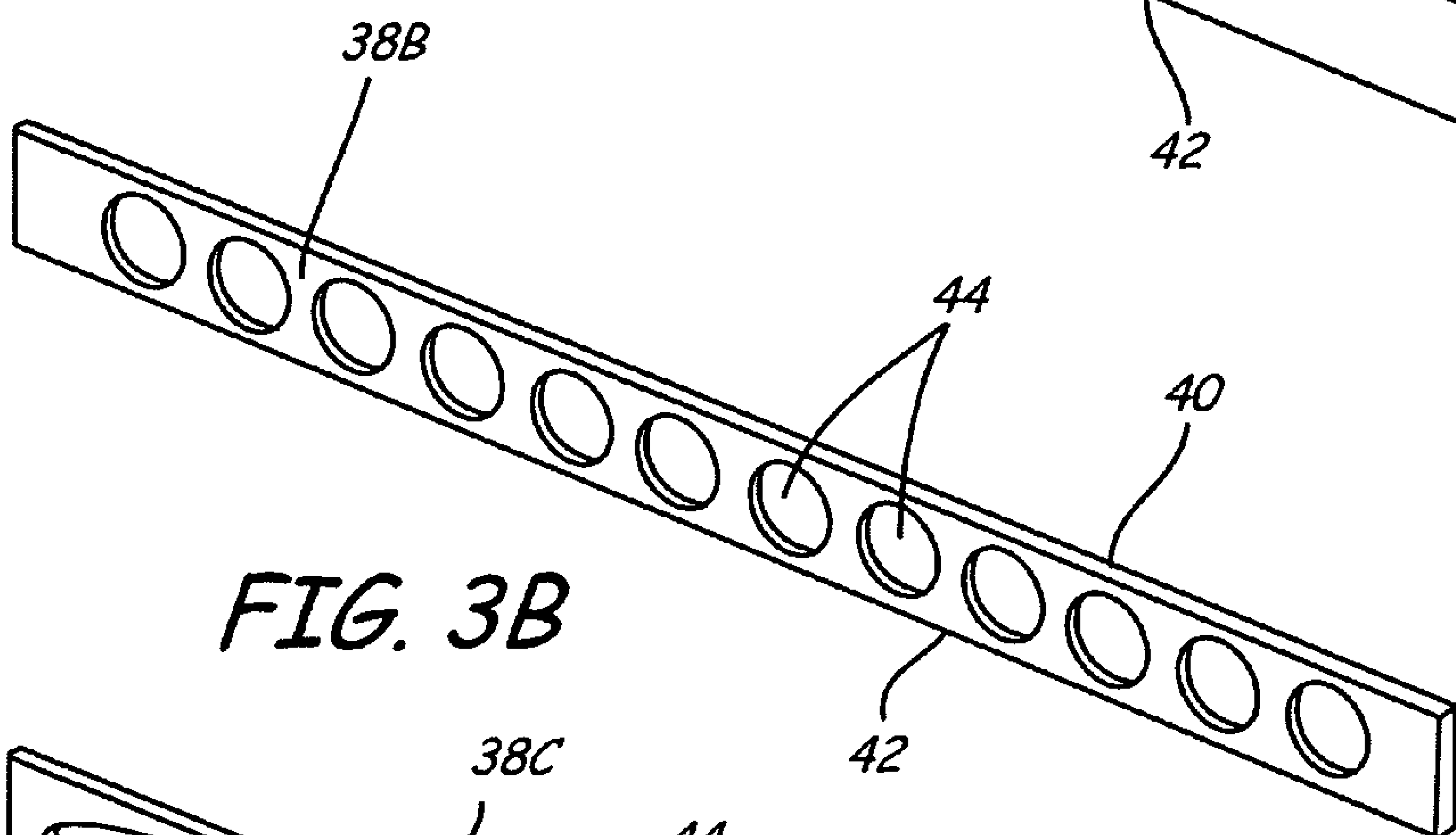

FIG. 3B

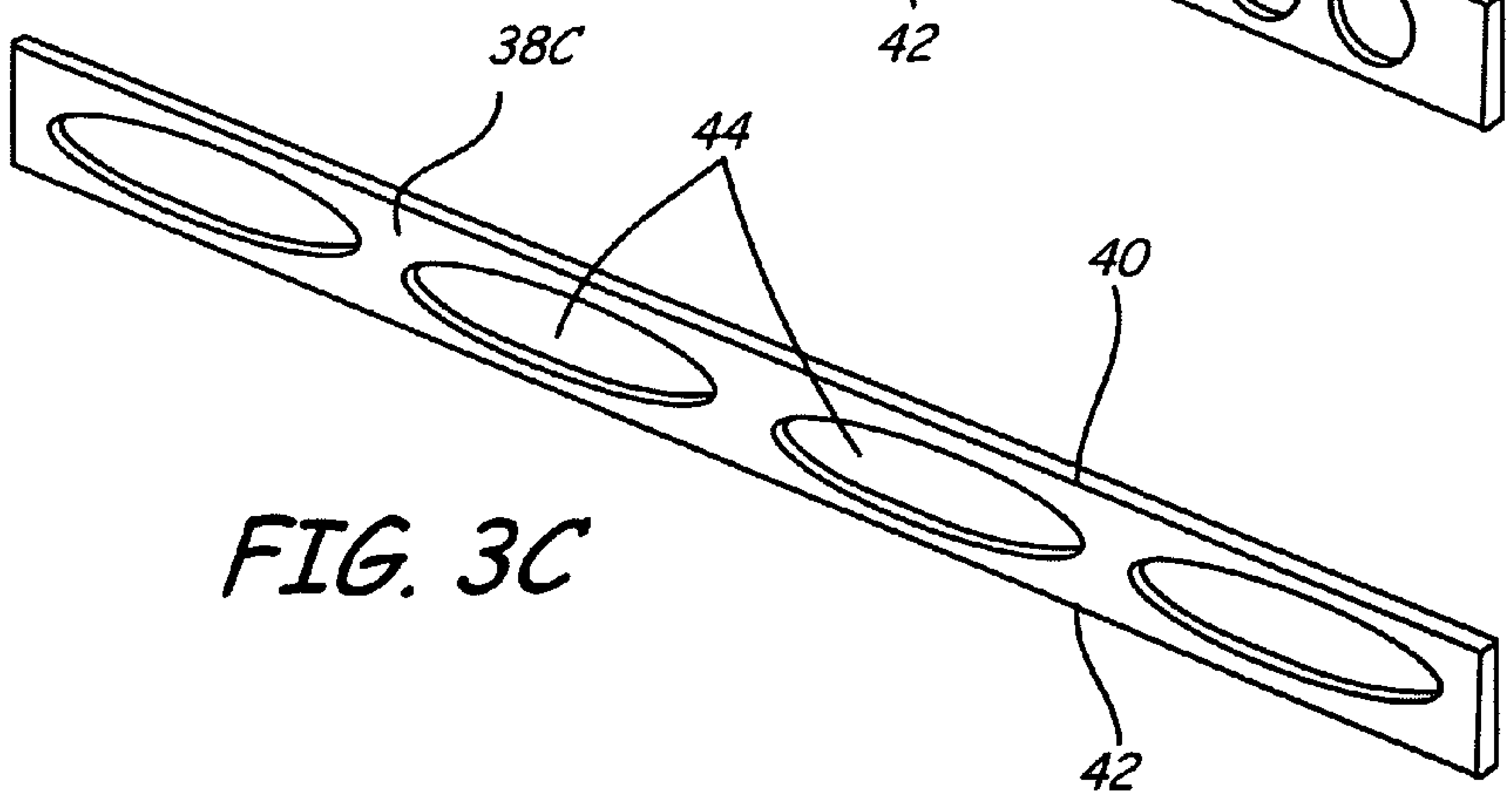

FIG. 3C

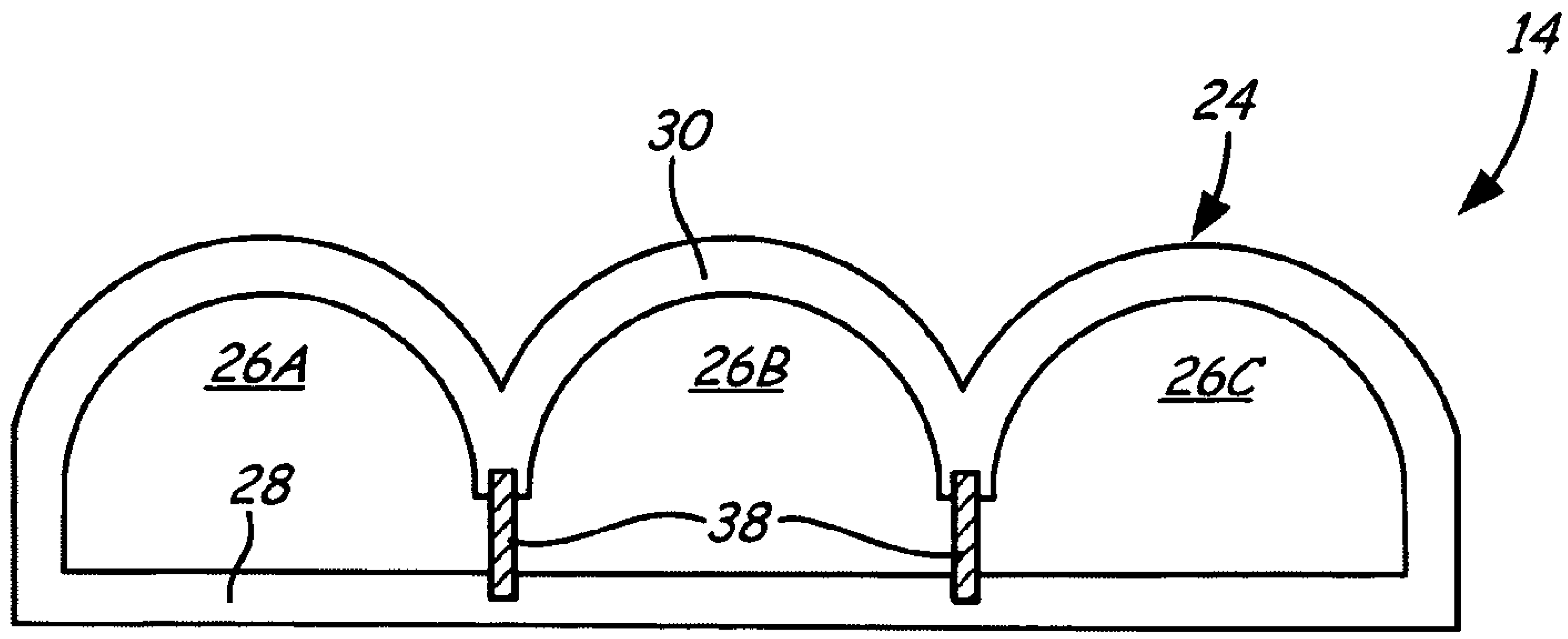

FIG. 4

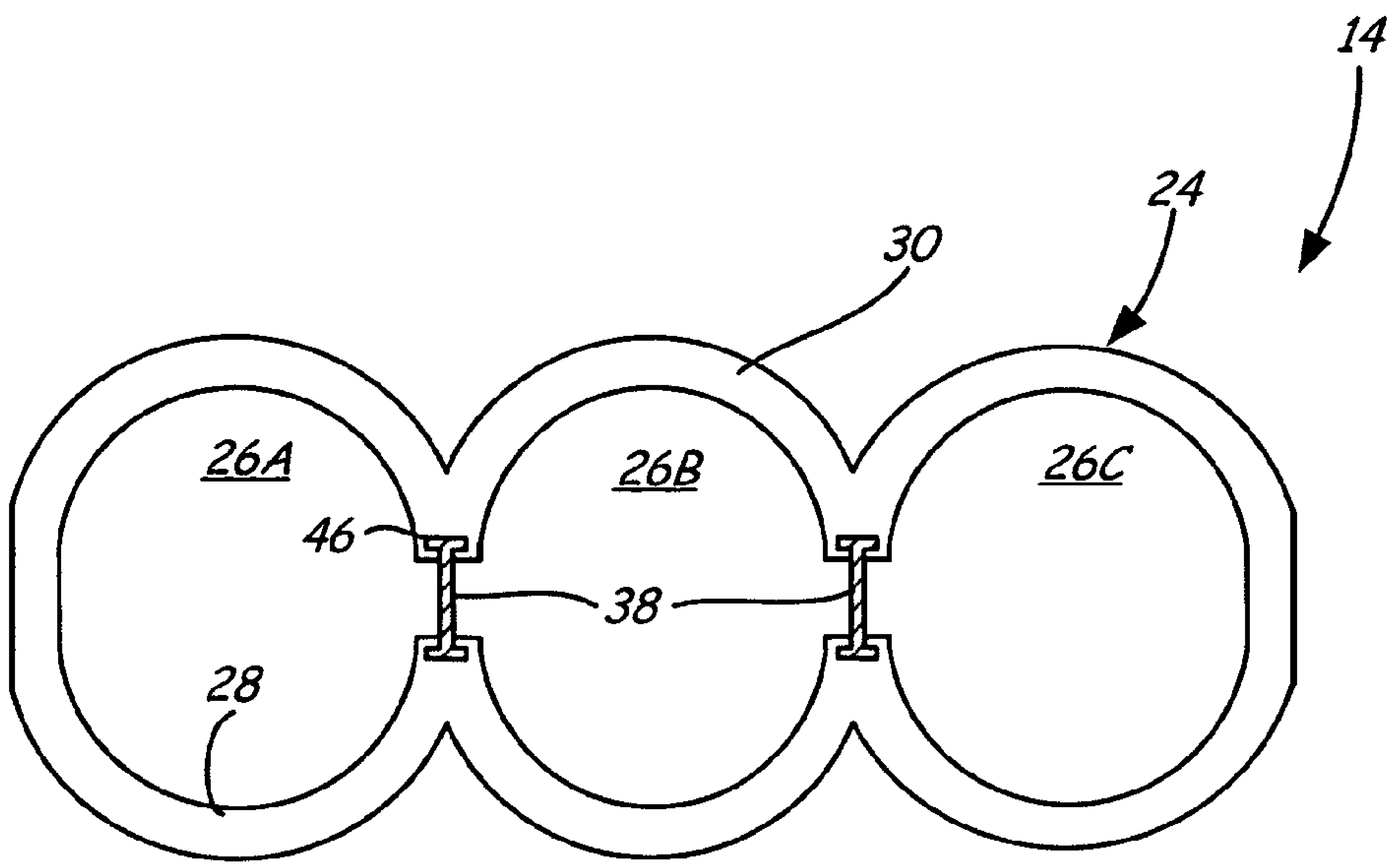

FIG. 5

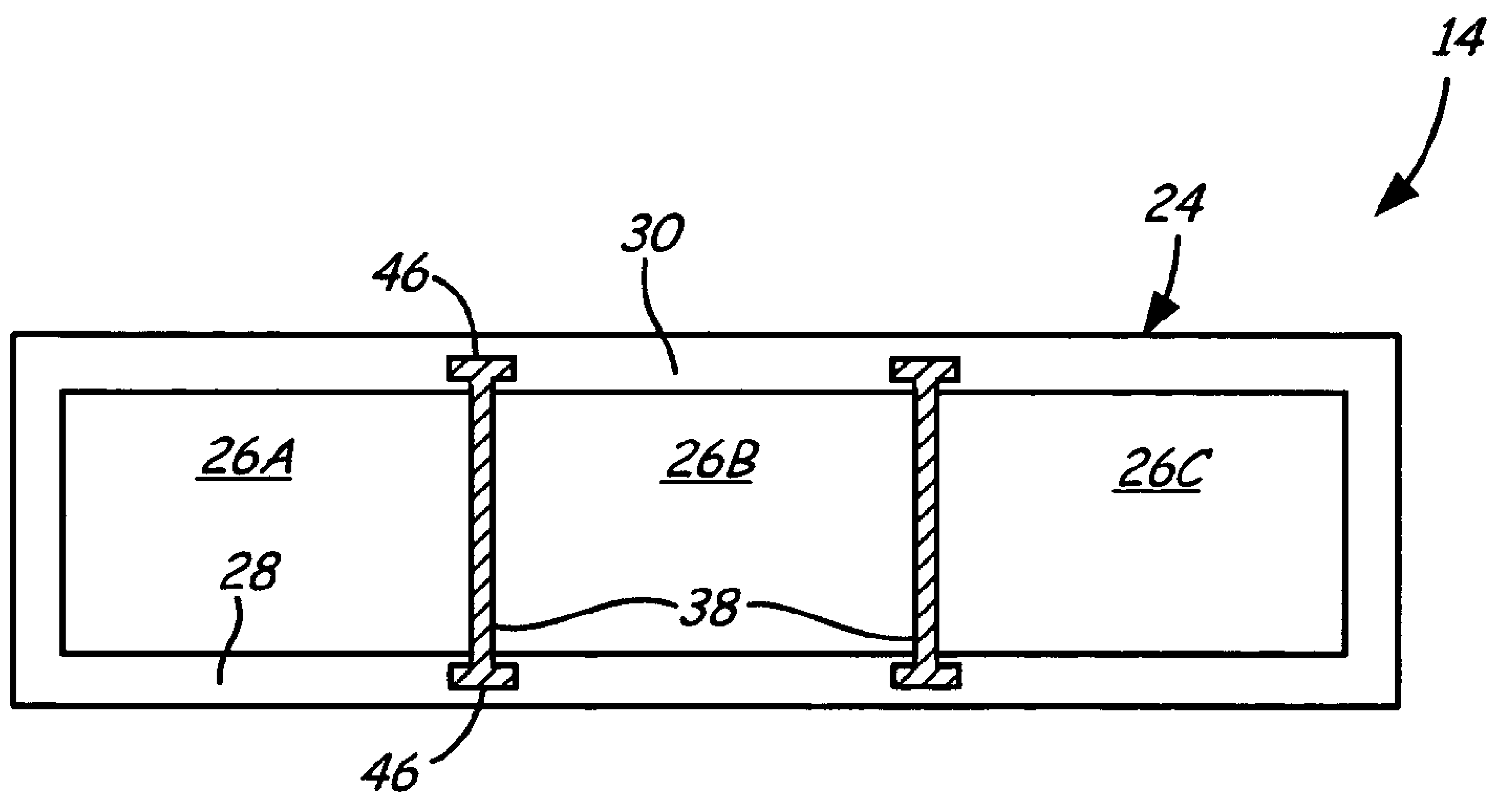
14
24
30
46
26A
26B
26C
28
38
46

FIG. 6

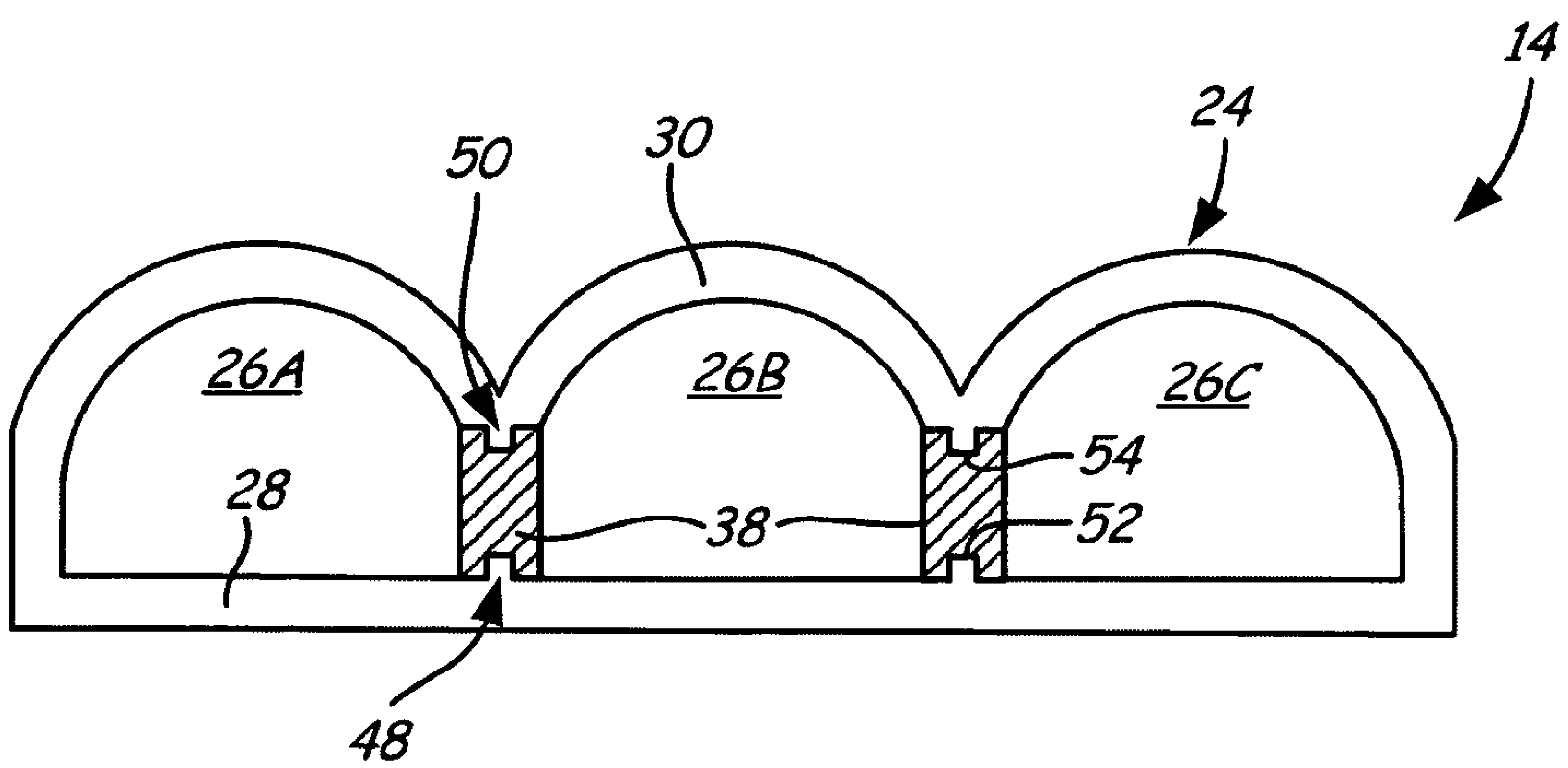
14
24
50
30
26A
26B
26C
28
38
54
52
48

FIG. 7

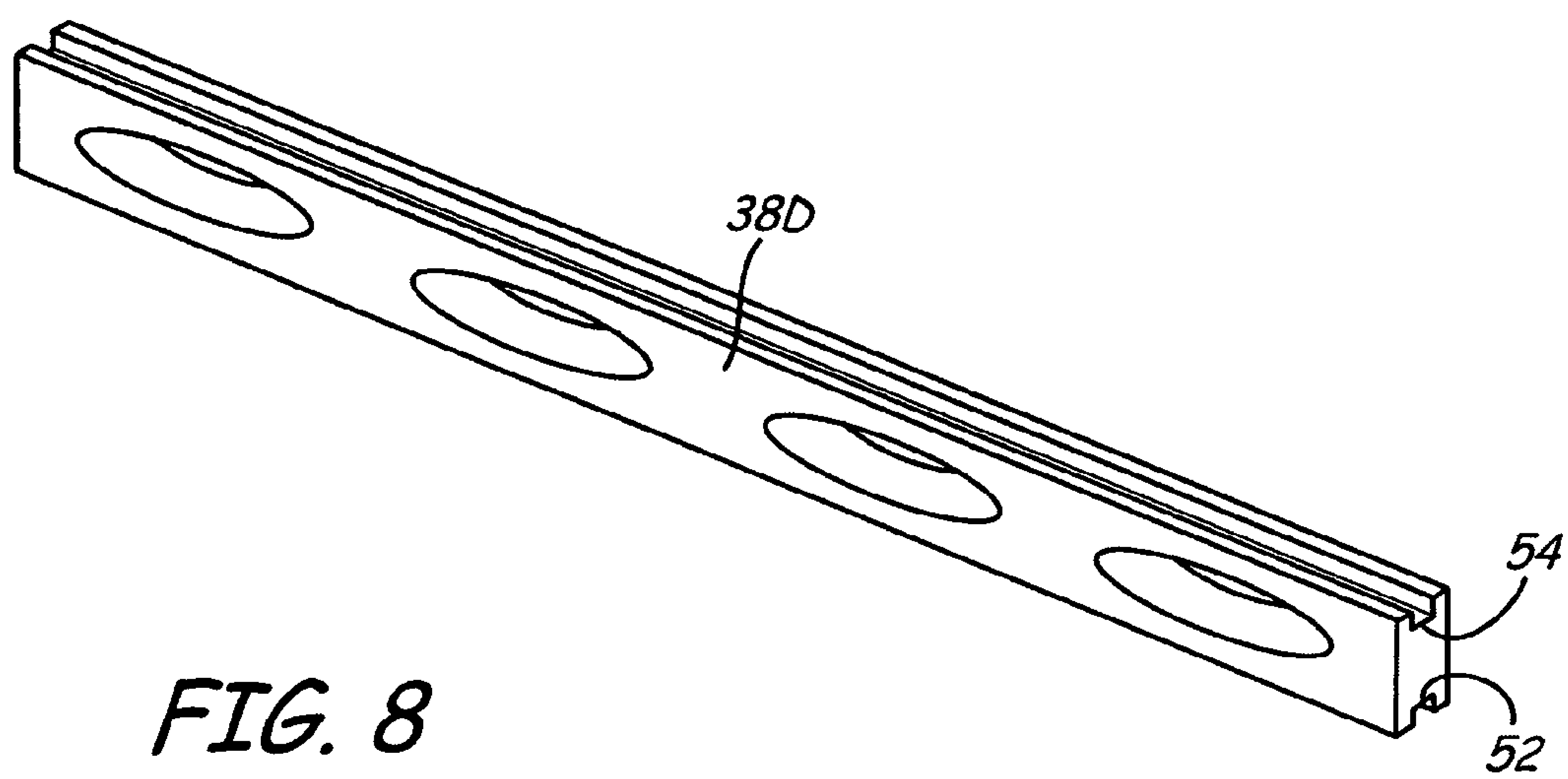

FIG. 8

MULTI-CHAMBER HEAT EXCHANGER HEADER AND METHOD OF MAKING

BACKGROUND

The present invention relates in general to heat exchangers, and more particularly, to a multi-chamber heat exchanger header that offers structural integrity while reducing manufacturing costs and complexity.

Headers used in multi-row mini- or micro-channel heat exchangers impart multiple manufacturing challenges. Heat exchanger headers must be strong enough to withstand the elevated pressures exerted by fluids flowing through the headers during operation. In some configurations, adjacent headers must also be in fluid communication with one another. Typically, heat exchanger headers are formed singly (e.g., one header for each row of tubes or channels) and are made from roll-formed, welded tubing or are formed by extrusion.

When multi-panel (e.g., multiple panels or slabs of adjacent micro-channels) heat exchangers are used, multiple single headers are connected together. Multiple headers are welded or brazed together at the inlet and outlet of each heat exchanger panel. In configurations where a header needs to be in fluid communication with an adjacent header, holes are first drilled into each header. The headers are then lined up so the holes in each communicate with one another and then the headers are welded or brazed together.

This process presents notable shortcomings. First, hole drilling must be performed on multiple headers in order for the headers to be in fluid communication. Second, the external welding or brazing joints between adjacent headers offer potential for leakage. Third, the headers have a thickness that is twice what is required in the area where they are connected. Because a header is formed singly and all walls of the header must be able to withstand the operating pressures of the working fluid, the header generally has a uniform thickness to ensure that the entire header is structurally sound. In the area where two headers connect (i.e. the area where the holes are drilled), the walls are prohibitively thick because each of the two headers contributes a generally uniform wall thickness.

SUMMARY

One embodiment of the present invention includes a heat exchanger header with a header housing and an insert. The header housing has a first wall and a second wall generally opposite the first wall where the first and second walls define a track. The insert is positioned to engage with the track such that the insert separates the header into first and second manifold chambers.

Another embodiment of the present invention includes a heat exchanger having first and second pluralities of fluid channels and a header. The header has a first manifold chamber fluidly connected to the first plurality of fluid channels, a second manifold chamber fluidly connected to the second plurality of fluid channels, and a separator plate separating the first and second manifold channels.

An additional embodiment includes a method for forming a heat exchanger header. The method includes extruding a header housing having first and second manifold chambers and a track, positioning an insert in the header housing to engage with the track and welding or brazing the insert to the header housing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a multi-panel heat exchanger.

FIG. **2** is a cross section view of one embodiment of a multi-row heat exchanger header housing.

FIG. **3**A is a perspective view of one embodiment of a solid insert.

FIG. **3**B is a perspective view of one embodiment of an insert with a plurality of passages.

FIG. **3**C is a perspective view of another embodiment of an insert with a plurality of passages.

FIG. **4** is a cross section view of the multi-row header of FIG. **2** with inserts in place.

FIG. **5** is a cross section view of one embodiment of a multi-row header with flanged inserts in place.

FIG. **6** is a cross section view of another embodiment of a multi-row header with flanged inserts in place.

FIG. **7** is a cross section view of a multi-row header with an alternate insert configuration.

FIG. **8** is a perspective view of one embodiment of a perforated insert compatible with the multi-row header of FIG. **7**.

DETAILED DESCRIPTION

The present invention provides a new design for heat exchangers and heat exchanger manifolds. FIG. **1** illustrates one embodiment of multi-panel heat exchanger system **10**. Multi-panel heat exchanger system **10** includes heat exchange panels **12**A, **12**B, **12**C; multi-chamber headers **14**, **16**; inlet **18**; outlet **20** and heat exchanger channels **22**. Multi-panel heat exchanger system **10** has three adjacent panels **12**A, **12**B and **12**C of heat exchanger channels **22**. While FIG. **1** shows an embodiment in which panels **12**A, **12**B and **12**C are arranged in a stack, other configurations are possible. Each panel **12** connects to first multi-chamber header **14** and second multi-chamber header **16**. First header **14** and second header **16** contain multiple chambers. In the embodiment illustrated in FIG. **1**, headers **14** and **16** each contain three manifold chambers (illustrated in greater detail in FIG. **2**). Multi-panel heat exchanger system **10** also includes inlet **18** and outlet **20**. Inlet **18** is in fluid communication with one chamber in first header **14** or second header **16** and outlet **20** is in fluid communication with a second chamber in first header **14** or second header **16**. Depending on the configuration of multi-panel heat exchanger system **10** and the direction of fluid flow, inlet **18** and outlet **20** can be on the same header **14**, **16** or different headers **14**, **16**.

In the embodiment illustrated in FIG. **1**, a working fluid (e.g., water, coolant, refrigerant, etc.) enters inlet **18** at the first chamber of first header **14**. The first chamber of first header **14** is not fluidly connected to the second chamber of first header **14** directly. Thus, working fluid travels from the first chamber of first header **14** through panel **12**C to the first chamber of second header **16**. The first chamber of second header **16** is in fluid communication with the second chamber of second header **16**. The second chamber of second header **16** is not fluidly connected to the third chamber of second header **16** directly. Thus, working fluid travels from the first chamber of second header **16** to the second chamber of second header **16** and then from the second chamber through panel **12**B to the second chamber of first header **14**. The second chamber of first header **14** is in fluid communication with the third chamber of first header **14** (but is not fluidly connected to the first chamber of first header **14** directly). Thus, working fluid travels from the second chamber of first header **14** to the third chamber of first header **14** and then from the third chamber through panel **12**A to the third chamber of second header **16**. The third chamber of second header **16** is not fluidly connected to the second chamber of second header

16 directly. Thus, working fluid exits multi-panel heat exchanger system **10** at outlet **20** from the third chamber of second header **16**.

A multi-chamber header reduces the design and manufacturing complexity of multi-panel heat exchanger system **10** while providing sound structural support. Multi-chamber headers **14** and **16** include header housing **24** and insert **38**. FIG. **2** illustrates a cross section view of one embodiment of header housing **24**. Header housing **24** defines three manifold chambers **26**A, **26**B and **26**C and includes walls **28** and **30** and grooves **32** and **34**. While header housing **24** in FIG. **2** defines three chambers **26**, other embodiments of header housing **24** can define any number of chambers greater than or equal to two. Chambers **26** are fluidly connected to each other within header housing **24**.

Header housing **24** includes walls **28** and **30**. Walls **28** and **30** are generally located on opposite sides of header housing **24**. In the embodiment illustrated in FIG. **2**, wall **28** is straight while wall **30** contains curved wall portions. Longitudinal ribs **29** are formed at the intersection of the curved wall portions of wall **30**. Walls **28** and **30** can serve to define chambers **26** (e.g., the curved portions of wall **30**) or they can merely serve to mete out the boundaries of chambers **26**. In this embodiment, wall **28** also has a plurality of openings that engage with a plurality of working fluid channels **22** (not shown in FIG. **2**).

Walls **28** and **30** contain grooves **32** and **34**, respectively. Grooves **32** and **34** are generally positioned opposite one another as shown in FIG. **2** to form a track, slot or guide channel **36**. Track **36** holds and guides insert **38** within header housing **24**. Track **36** formed by grooves **32** and **34** shown in FIG. **2** is generally perpendicular to wall **28**. However, grooves **32** and **34** do not necessarily need to be arranged to form a track, slot or guide channel **36** that is perpendicular to wall **28** or **30**. Formed track **36** can be at an incline relative to walls **28** and **30**. The positioning of grooves **32** and **34** and track **36** further define chambers **26**. For example, grooves **32** and **34** and track **36** in FIG. **2** indicate the intersection of chambers **26**B and **26**C. While the embodiment illustrated in FIG. **2** uses grooves **32** and **34** to define track **36**, other embodiments (described in detail below) can define track **36** using rails, ridges or projections.

FIGS. **3**A and **3**B illustrate two different embodiments of insert or separator plate **38**. FIG. **3**A shows solid insert **38**A. FIGS. **3**B and **3**C show two embodiments of perforated inserts **38**B and **38**C, respectively. All inserts **38** include first end **40** and second end **42**. Insert **38** is positioned within track, slot or guide channel **36** in header housing **24** formed by grooves **32** and **34** as illustrated in FIG. **4**. When inserted into header housing **24**, first end **40** is positioned within groove **32** and second end **42** is positioned within groove **34**. Once inserted, insert **38** can be welded or brazed to header housing **24**. Welding or brazing insert **38** to header housing **24** eliminates leakage that could occur between grooves **32**, **34** and first and second ends **40**, **42**. Welding or brazing also provides additional structural support to header housing **24**. Insert **38** has a longitudinal length equal to that of header housing **24**.

Solid inserts **38**A and perforated inserts **38**B and **38**C are positioned in header housing **24** to produce the desired flow paths of multi-panel heat exchanger system **10**. When solid insert **38**A is positioned within header housing **24**, insert **38**A prevents fluid from communicating between manifold chambers **26** adjacent insert **38**A. Insert **38**A serves as a fluid obstruction, preventing fluid from traveling from one manifold chamber **26** to the other. Perforated inserts **38**B and **38**C include one or more passages, perforations or orifices **44**. When, perforated inserts **38**B or **38**C are positioned within header housing **24**, inserts **38**B or **38**C allow fluid to communicate between manifold chambers **26** adjacent insert **38**B or **38**C. Passages **44** can be positioned and arranged along inserts **38**B and **38**C to provide uniform distribution of working fluid between chambers **26** as shown in FIG. **3**B. Insert **38** can have a rectangular cross section (as shown in FIGS. **3**A and **3**B), a flanged I-shaped cross section (as shown in FIG. **5**) or an irregular cross section (as shown in FIG. **8**). For optimal fit, the shape of grooves **32** and **34** will match the cross section shape of insert **38** and vice versa.

FIG. **4** illustrates one embodiment of completed header **14**. Inserts **38** are situated within the header housing **24** of FIG. **2**. Inserts **38** are positioned within track **36** formed by grooves **32** and **34**. Inserts **38** along with walls **28** and **30** define chambers **26**A, **26**B and **26**C. The type of insert **38** used determines whether two adjacent chambers **26** are in direct fluid communication. A solid insert **38**A prevents direct fluid connection while a perforated insert **38**B or **38**C allows direct fluid connection.

In addition to affecting fluid flow, inserts **38** also provide structural support for header housing **24** and header **14**. In operation, working fluids can be present in header **14** at elevated pressures. These elevated pressures exert force against walls **28** and **30**. The applied force pushes walls **28** and **30** away from one another. This can cause problems in a multi-chamber header without inserts. If the pressure and forces applied are too high, the walls can bulge or the structural integrity of the header can be compromised. Welded or brazed inserts **38** provide additional structural support for header housing **24**. Once welded or brazed into tracks **36**, inserts **38** hold walls **28** and **30** together and prevent them from separating. Inserts **38** prevent walls **28** and **30** from bulging or buckling, thereby increasing the structural strength of header **14**. Unlike the conventional headers that are formed singly, drilled and welded together externally, header **14** does not include a header housing **24** that contains prohibitively thick walls. Instead, header **14** is able to offer sound structural integrity by using inserts **38**.

FIG. **5** illustrates a cross section of another embodiment of header **14**. In this embodiment, header **14** includes walls **28** and **30**, each with curved portions. Inserts **38** are flanged at each end in the form of a T as shown in the FIG., such that the insert as a whole forms an I-shape. These flanged ends fit into correspondingly T-shaped tracks formed in walls **28** and **30**, as shown in FIG. **5**. This insert shape provides an even stronger connection between walls **28** and **30**. Not only does the welding or brazing of the insert serve to hold walls **28** and **30** together, but flanged ends **46** of insert **38** lock walls **28** and **30** together and provide additional support to prevent walls **28** and **30** from moving apart. FIG. **6** illustrates a cross section of another embodiment of header **14**. In this embodiment, header **14** is rectangular. Inserts **38** are flanged and longer relative to inserts **38** of FIGS. **4** and **5**.

FIG. **7** illustrates a cross section of another embodiment of header **14**. While headers **14** described in the earlier figures used a track **36** defined by grooves **32** and **34**, in this embodiment, track **36** is defined by rails or projections **48** and **50**. Rails **48** and **50** are located on wall **28** and wall **30**, respectively. Rails **48** and **50** work together to define track **36**. Since track **36** is defined by rails instead of grooves, the corresponding insert **38** requires a different shape to engage with track **36**. Here insert **38**D is wider (as shown in FIG. **8**) than inserts **38** of previous figures. Insert **38**D includes channels **52** and **54** which receive rails or projections **48** and **50**, respectively, to engage with track **36**. In this particular embodiment, insert **38** and header housing **24** engage across a larger surface area. This additional surface area engagement allows for additional brazing or welding contact, which can increase the support insert **38** provides to header **14**. While FIG. **7** illustrates rectangular projections (wall) and channels (insert), other suitable projection and channel shapes including trapezoidal (dovetail) are possible.

The present invention also provides a method of making multi-chamber header **14** described above. The method includes extruding a header housing having first and second manifold chambers and a track, positioning an insert in the header housing to engage with the track, and welding or brazing the insert to the header housing. Header housing **24** can be extruded from a single piece of material to yield the header housing **24** depicted in FIG. **2** including walls **28** and **30** and grooves **32** and **34**. Alternatively, header housing **24** can be extruded without grooves **32** and **34** and grooves **32** and **34** are later machined in walls **28** and **30**. Header housing **24** can also be extruded from a single piece of material to yield the header housing **24** depicted in FIG. **7** including walls **28** and **30** and rails **48** and **50**. Header housing **24** will contain two or more chambers **26** in direct fluid communication with one another following extrusion. Suitable materials for extrusion include aluminum and other extrudable metals such as copper and titanium. Dimensions of header housing **24** will vary depending on the size of the desired heat exchanger and the working fluid pressures used in the heat exchanger, but chamber widths of about 1.3 cm (0.5 inches) to about 7.6 cm (3 inches) and lengths of about 0.6 m (2 feet) to about 0.9 m (3 feet) and longer are not uncommon. Inserts **38** to be positioned in header housing **24** are made to have the same length as header housing **24** to prevent unwanted leakage between chambers **26**.

Once header housing **24** and inserts **38** (to be inserted in header housing **24**) have been formed, inserts **38** are positioned within tracks **36** formed by grooves **32** and **34** or rails **48** and **50** in header housing **24**. Typically, inserts **38** slide into place within tracks **36**. In embodiments where track **36** is defined by grooves, first end **40** of insert **38** occupies groove **32** and second end **42** occupies groove **34**. Once positioned, inserts **38** are welded or brazed to header housing **24**. The welding or brazing process fills in any gaps between first end **40** and groove **32** or rail **48** and between second end **42** and groove **34** or rail **50**.

The present invention provides for a multi-chamber heat exchanger header that is easier and less expensive to manufacture yet provides sound structural support. The header includes a housing capable of being extruded from a single piece of material and one or more inserts positioned within tracks or around rails of the header housing. The inserts offer structural support to the multi-chamber header and establish the flow path of the multi-panel heat exchanger system by allowing or prohibiting flow between the header chambers.

While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

The invention claimed is:

1. A heat exchanger header comprising:
- a first wall;
- a second wall generally opposite the first wall, wherein the first and second walls define T-shaped tracks, and wherein at least one of the first and second walls includes an aperture configured to communicate with a heat exchange channel; and
- an I-shaped insert with T-shaped ends generally opposite one another and positioned to engage with the T-shaped tracks and separate the heat exchanger header into first and second manifold chambers.

2. The heat exchanger header of claim **1**, wherein the insert is welded or brazed to the first and second walls.

3. The heat exchanger header of claim **1**, wherein the insert prevents fluid flow between the first and second manifold chambers.

4. The heat exchanger header of claim **1**, wherein the insert further comprises a passage for allowing fluid flow between the first and second manifold chambers.

5. The heat exchanger header of claim **1**, wherein the first and second walls are extruded as a single piece.

6. The heat exchanger header of claim **1**, wherein the first wall further comprises a curved portion.

7. A heat exchanger header comprising:
- a first wall;
- a second wall generally opposite the first wall, wherein the first and second walls define T-shaped tracks, wherein the track comprises a first groove in the first wall and a second groove in the second wall, and wherein at least one of the first and second walls includes an aperture configured to communicate with a heat exchange channel; and
- an I-shaped insert with T-shaped ends positioned to engage with the T-shaped tracks and separate the heat exchanger header into first and second manifold chambers, the insert comprising:
  - a first T-shaped end positioned within the first groove; and
  - a second T-shaped end positioned within the second groove.

8. The heat exchanger header of claim **1**, wherein the first and second walls define a second set of T-shaped tracks, and further comprising:
- a second I-shaped insert with T-shaped ends positioned to engage with the second set of T-shaped tracks and separate a third manifold chamber from the second manifold chamber.

9. A heat exchanger comprising:
- a first plurality of fluid channels;
- a second plurality of fluid channels; and
- a header comprising:
  - a first manifold chamber fluidly connected to the first plurality of fluid channels;
  - a second manifold chamber fluidly connected to the second plurality of fluid channels; and
  - an I-shaped separator plate separating the first and second manifold chambers, the separator plate comprising:
    - a first T-shaped end;
    - a second T-shaped end generally opposite the first T-shaped end;
  - a first wall; and
  - a second wall generally opposite the first wall, wherein the first and second walls define T-shaped tracks, and wherein the separator plate is positioned to engage with the tracks.

10. The heat exchanger of claim **9**, wherein the separator plate is welded or brazed to the header.

11. The heat exchanger of claim **9**, wherein the separator plate prevents fluid flow between the first and second manifold chambers.

12. The heat exchanger of claim **9**, wherein the separator plate further comprises a passage for allowing fluid flow between the first and second manifold chambers.

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